DOE/RL-95-80
Rev. 0

Construction Close-out Report for 1100-EM-1, 1100-EM-2, and 1100-EM-3 Operable Units, Hanford, Washington

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Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

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CONTENTS

FIGURES

TABLES

ACRONYMS

BEHP	bis (2-ethylhexyl) phthalate
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CLP	Contract Laboratory Program
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington State Department of Ecology
EM-1	1100-EM-1 (Operable Unit)
EM-2	1100-EM-2 (Operable Unit)
EM-3	1100-EM-3 (Operable Unit)
EPA	U.S. Environmental Protection Agency
HRL	Horn Rapids Landfill
LFI/FFS	limited field investigation/focused feasibility study
MCL	maximum contamination level
MTCA	[State of Washington] *Model Toxics Control Act*
NESHAP	National Environmental Standards for Hazardous Air Pollutants
NPL	*National Priorities List*
PCB	polychlorinated biphenyls
PCS	petroleum-contaminated soil
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
TPH	total petroleum hydrocarbons
TSCA	*Toxic Substances Control Act*
USACE NPD	U.S. Army Corps of Engineers North Pacific Division
UST	underground storage tank
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

This report provides summary descriptions of waste sites, remedial investigations, cleanup actions, and revegetation, as well as other information about the 1100 Area at the Hanford Site, in Richland, Washington. The intent is to provide the documentation necessary for the close-out of remedial work in the 1100 Area and for the delisting from the *National Priorities List* (NPL). The content and format of this report follows the U.S. Environmental Protection Agency (EPA) guidance (EPA 1991a, EPA 1991b).

2.0 SUMMARY OF SITE CONDITIONS

2.1 SITE DESCRIPTION

2.1.1 General

The 1100 Area consists of approximately 1,200 acres at the southern portion of the Hanford Site (Figure 1) and is adjacent to the city of Richland's industrial areas and the North Richland well field. The 1100 Area was placed on the NPL in July 1989. The 1100 Area NPL site is divided into four operable units, based on geographic area and similarity of waste sources. The four operable units are the 1100-IU-1, the 1100-EM-1 (EM-1), the 1100-EM-2 (EM-2), and the 1100-EM-3 (EM-3), and each is shown in Figures 2, 3, and 4, respectively. Closure action for the 1100-IU-1 Operable Unit was previously proposed in U.S. Department of Energy, Richland Operations Office (DOE-RL) 1994a and will not be addressed in this report.

Before development for the Hanford Site mission, the 1100 Area was principally used for agricultural purposes, with small farms and water ditches as its primary features. In 1943, construction of temporary office buildings for Camp Hanford began in the EM-3 area, and development of the EM-3 and surrounding areas continued through the 1940s for office buildings, off-loading, and warehousing of construction supplies brought in for Hanford Site construction (DOE-RL 1993). Landfill operations began at the Horn Rapids Landfill (HRL) in the late 1940s (DOE-RL 1992). The EM-2 area was developed in the early 1950s for vehicle maintenance.

The 1100 Area is underlain by the Hanford formation, the Ringold Formation, and the Ice Harbor Flow of the Saddle Mountains Basalt. The Hanford formation consists of 12 to 15 m (40 to 50 ft) of interbedded sandy gravel, gravely sand, and silty sandy gravel. The Ringold Formation consists of 46 to 49 m (150 to 160 ft) of fluvial gravels and interbedded silt and sands (DOE-RL 1990a). Depth to the groundwater vies between 6 m (20 ft) at the west side of the HRL (EM-1) and 18 m (60 ft) at the EM-3. The upper aquifer is unconfined and varies in thickness from approximately 5 m (16 ft) on the west side of the HRL to 13 m (44 ft) near the discolored soil site (EM-1; Figure 2). Groundwater flow in the unconfined aquifer is from the west (recharge from the Yakima River) to the east (discharge to the Columbia River) (DOE-RL 1993).

Figure 1. Hanford Reservation Location Map.

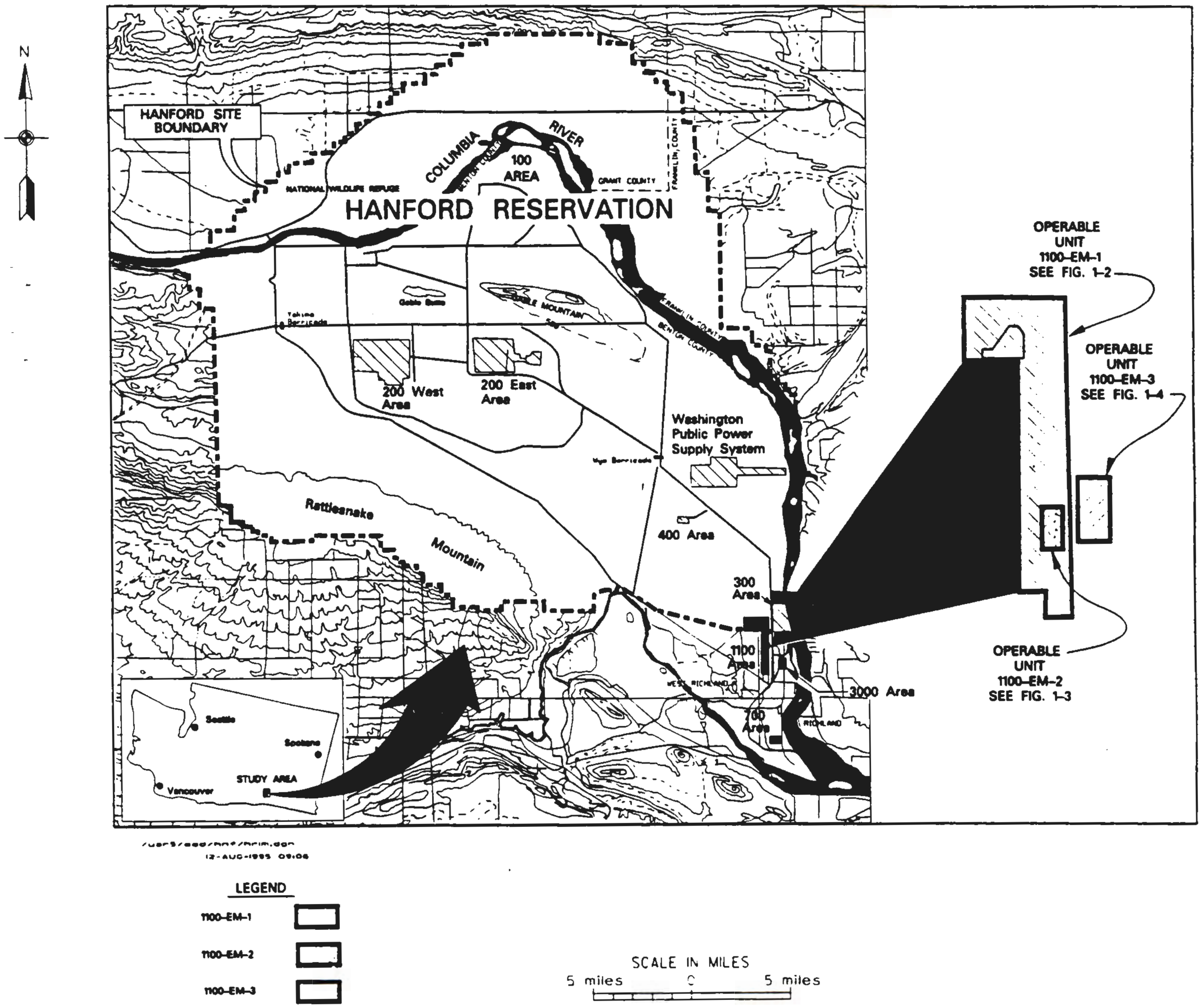


Figure 2. 1100-EM-1 Operable Unit.

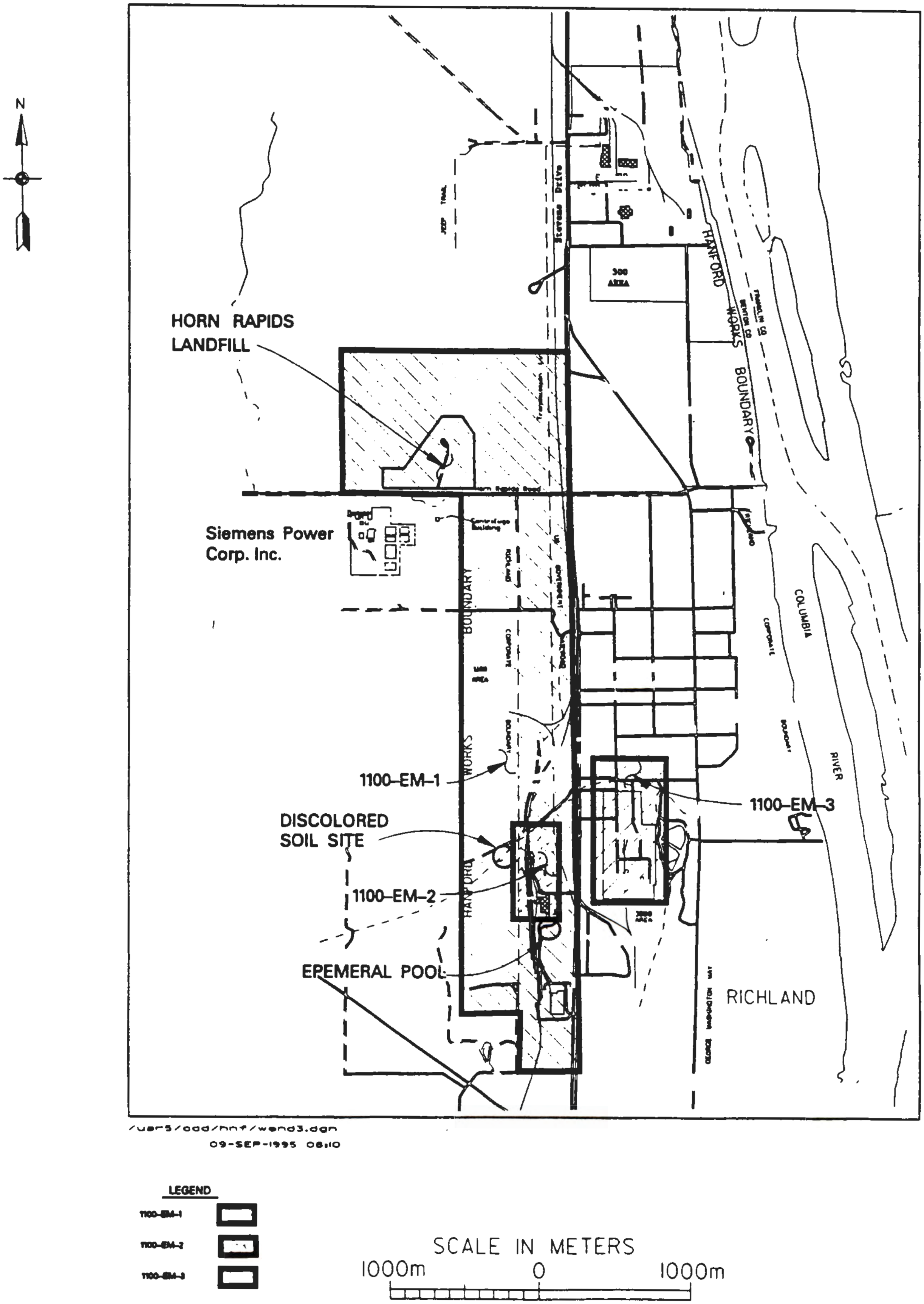


Figure 3. 1100-EM-2 Operable Unit.

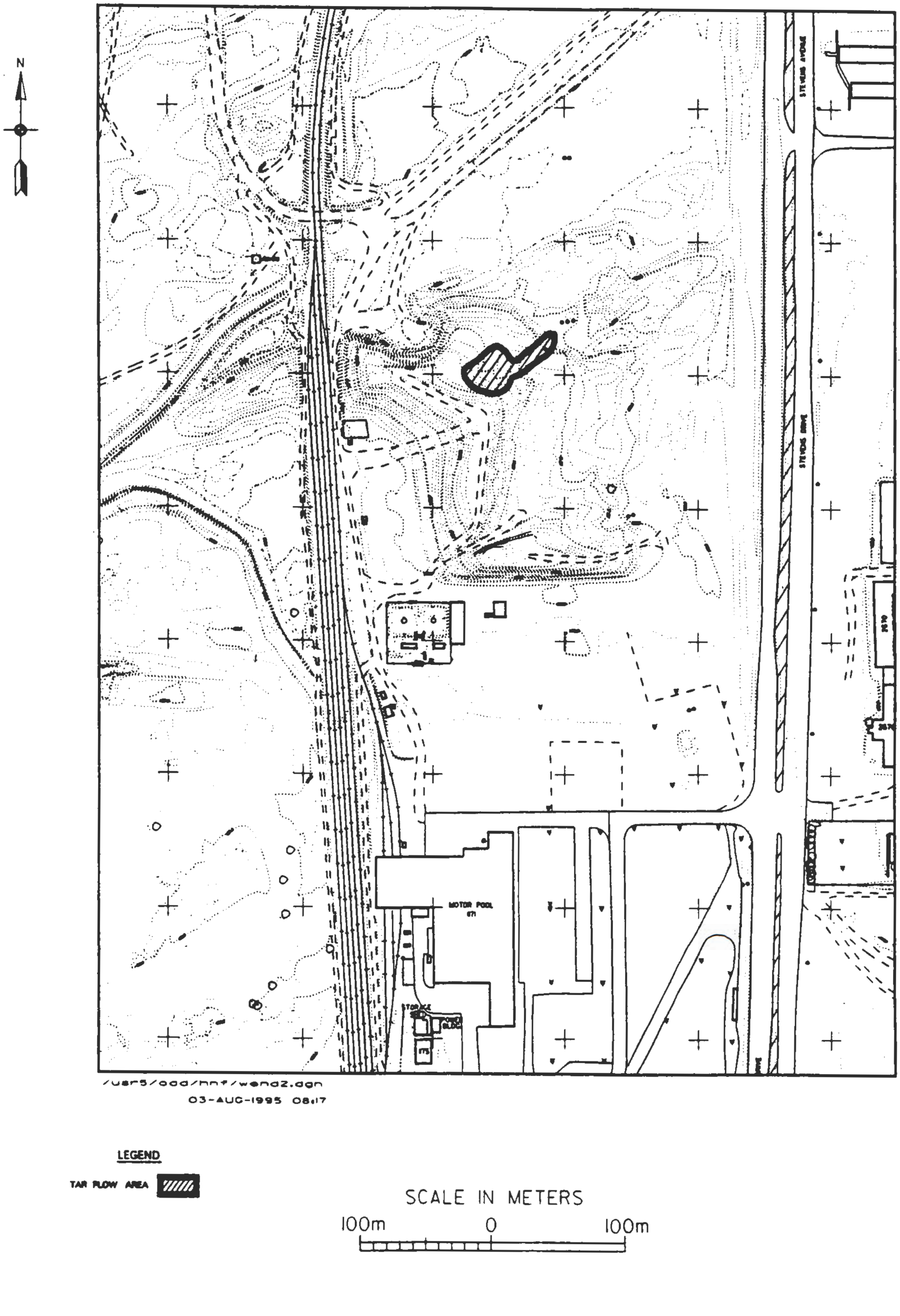
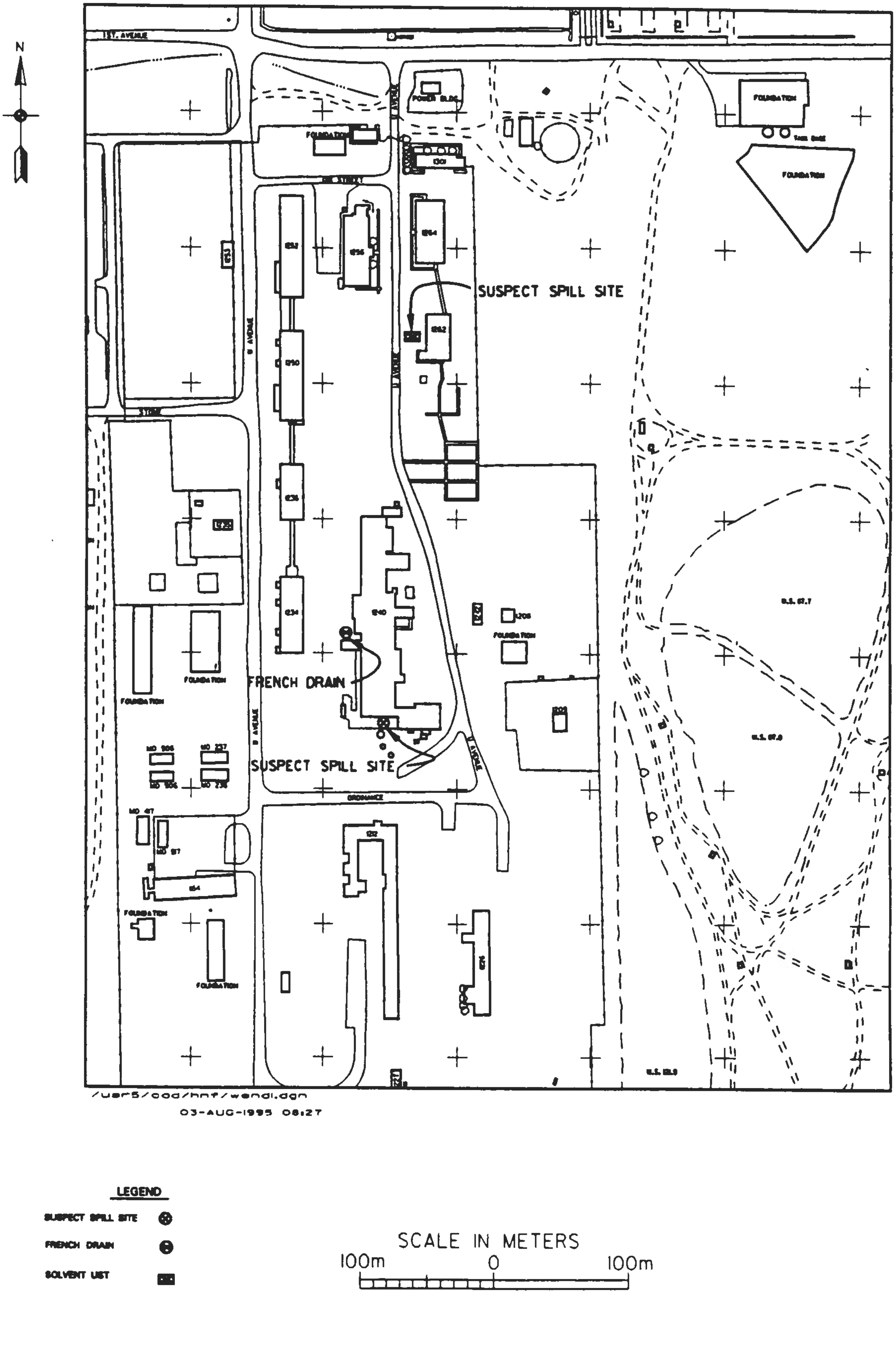


Figure 4. 1100-EM-3 Operable Unit.



The seasonal pattern of groundwater flow at EM-2 and EM-3 is disrupted by recharge at the North Richland well field (DOE-RL 1992).

The 1100 Area is semiarid land with a sparse covering of cold desert shrubs and drought-resistant native and nonnative grasses in undeveloped areas. No wetlands are contained within the boundaries of the 1100 Area, and the area is located outside of any 100-year floodplains.

2.1.2 EM-1 Operable Unit

The EM-1 Operable Unit currently includes offices and transportation-related support facilities. Previous activities at the operable unit included landfill operations at the HRL, offices, warehousing, and transportation-related operations. Operations at EM-1 have included the use of solvents, fuels, oils, and polychlorinated biphenyls (PCB) (DOE-RL 1992).

2.1.3 EM-2 Operable Unit

The EM-2 Operable Unit currently includes the 1171 Building and adjacent areas. The 1171 Building was constructed in the 1950s and is currently used for vehicle and equipment maintenance. The EM-2 also supports transportation-related activities, such as gas station services. The Hanford Site bus transportation system operated out of the 1171 Building until 1994. Operations at EM-2 potentially included the use of solvents, fuels, oils, and PCBs (DOE-RL 1992).

2.1.4 EM-3 Operable Unit

The EM-3 Operable Unit includes approximately 20 structures, some dating back to 1951, when the temporary construction to support Camp Hanford was demolished and was replaced with permanent facilities. Recent activities at EM-3 include paint and sandblast operations, vehicle maintenance and repair, hazardous material storage, *Resource Conservation and Recovery Act* (RCRA) waste accumulation areas, warehousing, fabrication shops, radio maintenance, and radiography and research administrative offices. Historic operations at EM-3 included automotive repair and maintenance shops, gasoline storage and dispensing stations, artillery repair and maintenance shop, laundry, dry cleaner, cold storage, warehouses, bakery, troop barracks, and administrative offices (DOE-RL 1992).

2.2 REMEDIAL INVESTIGATION AND FEASIBILITY STUDY AND FIELD INVESTIGATION RESULTS

2.2.1 General

Investigations for the EM-1 Operable Unit followed the traditional *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) format for remedial investigation/feasibility study (RI/FS). The EM-2 and EM-3 Operable Units did not follow the RI/FS process; alternatively, investigations for these two operable units were abbreviated and consisted of a limited field investigation/focused feasibility study (LFI/FFS). In the fall of 1992, the EPA, the Washington State Department of Ecology (Ecology), and the U.S. Department of Energy (DOE) accelerated the study and evaluation of the EM-2 and EM-3 so the remedial action for these units could be combined with the remediation of EM-1 and could proceed as a single project.

The investigations for EM-2 and EM-3 were developed as a single approach, which is described in the following paragraphs. The unique aspects of the investigation are described in the following sections of the report that are dedicated to the individual operable units. The investigations for the EM-2 and EM-3 Operable Units began in 1992 with an LFI (DOE-RL 1993) that consisted of reviews of historical information (i.e., aerial photographs, records, detailed visual inspections, interviews with site personnel, and review of previous characterization efforts). A preremediation investigation was conducted during 1994 that included geophysical surveys, soil gas sampling, and soil sampling (DOE-RL 1994b).

Because the investigations for the EM-2 and EM-3 were not exhaustive, the risk assessment approach was not as specific as the approach used for the EM-1, and the remedial action objectives were more broadly defined. A qualitative evaluation of overall potential risk from the EM-2 and EM-3 was made by comparing possible waste site contaminant concentrations with existing state and federal health-based guidelines (principally, the State of Washington *Model Toxics Control Act* [MTCA]). The guidelines from the qualitative evaluation form the basis of the cleanup goals for the EM-2 and EM-3 Operable Units.

2.2.2 EM-1 Operable Unit

Based on past practices and anecdotal information from the EM-1, 10 sites were identified for investigation: the battery acid pit, the paint and solvent pit, the antifreeze and degreaser pit, the antifreeze tank site, the radiation contamination incident site, the discolored soil site, the HRL, the ephemeral pool, pit 1, and the south pit. The antifreeze tank site was part of the EM-2 Operable Unit, but was investigated and remediated during EM-1 investigation work (DOE-RL 1992). Operable unit characterization investigations started in 1989, and a phase one remedial investigation report was produced in 1990 (DOE-RL 1990a). These activities were followed with a phase one and two feasibility study report (DOE-RL 1990b). The phase two remedial investigations began in 1991, and a draft phase two remedial investigation report/phase three feasibility study (DOE-RL 1992) was submitted in 1992.

The characterization and analysis performed for the phase two remedial investigation indicated that groundwater contamination has moved to the EM-1, near HRL. An adjacent facility is investigating soil and groundwater contamination as an independent action (EPA 1993).

During the RI/FS, the baseline risk assessment determined that the incremental cancer risk was greater than 10^{-6} for the discolored soil site, the ephemeral pool, and the HRL. The incremental cancer risks computed for the remaining sites were less than 10^{-6}. The baseline risk assessment included computation of risk for both industrial and residential land-use scenarios. Hazard quotients for the baseline risk assessment were less than one for all sites in the industrial land-use scenario, and were greater than one for the discolored soil site, the ephemeral pool, and the HRL, as in the case of the residential land-use scenario. The baseline risk assessment was based on exposure to contaminated soil by ingestion, dermal exposure, and fugitive dust inhalation. Potential exposures associated with groundwater and surface water were not evaluated in the industrial land-use scenario because neither are consumed in the 1100 Area because water is provided by the city of Richland. The remedial action objectives developed for the EM-1 are shown in Table 1.

Table 1. Remedial Action Objectives for EM-1.

Site	Contaminant	Remedial Objective (mg/kg)
HRL	PCB	5.2
Discolored soil site	bis (2-ethylhexyl) phthalate (BEHP)	71
Ephemeral pool	PCB	1

Although asbestos was not considered in the risk assessment (there were no published reference doses or carcinogenic potency factors for asbestos), asbestos at the HRL poses a health risk to onsite workers. Containment of the asbestos is a remedial action objective for the EM-1. The volumes of contaminated soil for the remedial objectives shown in Table 1 were estimated to be 226 m^3 (296 yd^3) for the HRL, 340 m^3 (440 yd^3) for the discolored soil site, and 250 m^3 (340 yd^3) for the ephemeral pool.

The final feasibility study for the EM-1 considered a variety of remedial alternatives for the soil contamination, including no action, institutional controls, and removal/treatment. The removal/treatment alternative included bioremediation, onsite incineration, offsite incineration, offsite disposal, and supercritical carbon dioxide extraction. Remedial alternatives considered for the HRL included a municipal and solid waste landfill cap and an asbestos cap. The groundwater contamination remedial alternatives included no action, institutional controls, various pump-and-treat alternatives with different production rates, and methods of treatment for contaminant removal. The estimated cost for the soil contamination alternatives ranged from $802,000 for the no action alternative to $9,639,000 for offsite incineration of soil contaminants and capping the HRL with a municipal solid waste landfill cap (DOE-RL 1992). The estimated cost for the groundwater remediation alternatives ranged from $0 for the no action alternative to $9,970,000 for the pump-and-treat alternative (which has the shortest duration for remediation).

2.2.3 EM-2 Operable Unit

Based on past practices and anecdotal information from the EM-2, the principal sites investigated during the LFI (in 1992 and 1993) were the tar flow and stained sands areas, Neptune's potato and separator tank, several used oil tanks (#4 to #6), steam pads (#1 and #2), the bus shop underground hoist ram, the 700 Areas, the waste solvent tank, the bus lot dry wells, and a hazardous waste staging area (DOE-RL 1993). Groundwater analytical results were reviewed during the LFI, and nitrate was identified as a potential contaminant of concern. Many sites were currently under regulation by the state or EPA (under a statute other than CERCLA or MTCA), or several sites were candidates for regulation under programs other than CERCLA or MTCA (these sites were removed from further consideration in this program). Sites that remained in the CERCLA investigation for EM-2 were the tar flow area, the stained sands area, and the Neptune's potato and separator tank. These sites were further investigated by geophysical surveys, soil gas sampling, and soil sampling conducted in 1994 during the preremediation investigation.

Based on the results from the 1994 investigation and the cleanup goals for EM-2 and EM-3, the tar flow area was identified for remedial action (the stained sands area is combined with the tar flow area for remedial action) (DOE-RL 1994b). The remedial action cleanup levels for the tar flow area for the contaminants identified at the site during investigations are shown in Table 2.

Table 2. Remedial Action Cleanup Levels for the Tar Flow Area.

Contaminant	Remedial Objective (mg/kg)
Total petroleum hydrocarbons (TPH)	200
Lead	250

The volume of contaminated soil at the tar flow area was estimated to be 385 m^3 (500 yd^3). The alternatives considered for contaminated soil remediation at the EM-2 Operable Unit include no action, offsite disposal, and onsite incineration.

Recent groundwater sampling (three rounds of sampling have been performed since March 1992) results for the EM-2 are summarized in Table 3 and indicate that concentrations of nitrate are below the maximum contamination level (MCL) of 10 mg/L.

Table 3. Recent Groundwater Sampling Results for EM-2.

Analyte	Well #	# Rounds Considered	Average mg/L	Maximum mg/L
Nitrate	MW-1	10, 14, and 18	5.21	6.56
Nitrate	MW-3	10, 11, 14, and 18	1.57	3.11

2.2.4 EM-3 Operable Unit

Based on past practices at the EM-3, approximately 22 sites were identified during the 1992/1993 LFI (DOE-RL 1993). Groundwater analytical results were reviewed during the LFI, and no contaminants of concern were identified. Many sites were currently under regulation by the state or EPA (under a statute other than CERCLA) or were candidates for regulation under programs other than CERCLA. These sites were removed from further consideration in this program. Sites remaining in the CERCLA investigation for EM-3 were the 1240 Suspect Spill Area, 1240 French Drain, 1226 Suspect Waste Oil Disposal Area, 1212/1217 Suspect Battery Acid Disposal Area, 1218 Service Station, 1262 Solvent Tanks, 1262 Transformer Pad, JA Jones Oil Storage Tanks, and JA Jones Steam Plant Drain Pad. These remaining sites were further investigated by geophysical surveys, soil gas sampling, and soil sampling conducted as part of the 1994 preremediation investigation.

Based on the preremediation investigation results and the cleanup goals for EM-3, the French drain, suspect spill area, and 1262 Solvent Tanks were identified for remedial action (DOE-RL 1994b). The remedial action cleanup levels are shown in Table 4 for the contaminants identified at the EM-3 during investigations.

Table 4. Remedial Action Cleanup Levels for EM-3.

Site	Contaminant	Remedial Objective (mg/kg)
Suspect spill	Lead	250
French drain	TPH	200
	Lead	250
	Chromium	400

The volume of contaminated soil at the French drain was estimated to be 19 m^3 (25 yd^3), and the volume of waste at the suspect spill site was estimated to be 92 m^3 (120 yd^3). The solvent underground storage tank (UST) investigations identified two USTs, each with approximately 4,275-l (1,125-gal) capacities. Anecdotal information indicates that these tanks were used to store dry-cleaning solvents; however, no samples were collected from the tanks during the investigation. The remedial alternatives considered for EM-3 included no action, offsite disposal, and onsite incineration.

2.3 RECORD OF DECISION

The proposed plan was made available to the public on May 24, 1993, and the public review/comment period was extended to July 9, 1993. A public meeting was held on June 30, 1993, at the city of Richland Public Library. Few comments were received on the proposed plan.

The EPA, Ecology, and DOE agreed to set cleanup standards to the MTCA residential levels, where practicable. The RI/FS concluded that it is practical to meet the MTCA residential levels at all sites except the HRL, where an industrial level was established for the cleanup of PCBs. Groundwater contamination does not present any risk to human health; however, EPA, Ecology, and DOE agreed to meet the MTCA groundwater standards.

The Record of Decision (ROD) for the 1100 Area (EPA 1993) specified that contaminated soils would be disposed of off site, except for BEHP-contaminated soils from the discolored soil site, which would be disposed of by offsite incineration. The ROD specified the closure of the HRL as an asbestos landfill in accordance with National Environmental Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61.151) asbestos requirements. Cleanup requirements established by the ROD for soil contamination are summarized in Tables 1, 2, and 4. Additionally, compliance with the MCL of 5 μg/L was specified for trichloroethylene contamination of groundwater at the HRL. The remedial action for achieving compliance was specified as natural attenuation and groundwater monitoring to confirm that the remedial action objectives are being achieved. Institutional controls were specified for the duration of the cleanup, and future controls were also specified on the installation of groundwater wells in the plume of its path until remedial action objectives have been attained. The DOE was required to make a notation of these controls on the deed to the HRL property, as specified in the asbestos NESHAP (40 CFR 61).

2.4 REMEDIAL ACTIVITIES

2.4.1 General

The remedial activities for the 1100 Area were performed in accordance with a series of work plans submitted by DOE to EPA and Ecology (DOE-RL 1994c, DOE-RL 1995a, DOE-RL 1995b, DOE-RL 1995c, and DOE-RL 1995d). Brief summaries of the remedial activities are provided in the following sections (detailed descriptions are provided in DOE-RL 1995e).

The approach for removing contaminated soil in the 1100 Area was generally the same at each operable unit site. The unique aspects of the remedial activities for each operable unit are described in the following sections of the report dedicated to the individual operable unit. Before excavating contaminated soil sites, the locations where soil samples were collected during previous investigations were surveyed and staked by the U.S. Army Corps of Engineers North Pacific Division (USACE NPD). Contaminated soil removal was accomplished using a crawler-mounted backhoe. Excavation at each site began in the area of known contamination (which was based on earlier investigation efforts) and proceeded downward and outward, based on visual evidence of contamination and the results of onsite screening analyses conducted in the mobile laboratory. Contaminated soils were stockpiled on 10-mil plastic sheeting and were covered with heavy-gauge tarps at the end of each day. When the field screening indicated that the appropriate cleanup levels had been achieved, confirmation samples were collected (EPA quality control [QC] levels and analysis, as described in DOE-RL 1995d). Additional sampling and analysis of the waste stockpiles were performed, as necessary, for waste disposal based on the determination of waste acceptance criteria compatibility and designation/classification of the waste. The waste was transported to the disposal facilities by State of Washington-licensed hazardous waste transporters following the approval of waste profiles by the disposal facilities. The MCLs for contaminants analyzed during remediation are summarized in Table 5.

Table 5. Maximum Contaminant Levels in the 1100 Area.

Waste Site ID	Contaminant	Max Concentration
HRL	PCB	165
Discolored soil site	BEHP	605
Ephemeral pool	PCB	25
Tar flow area	TPH Lead	6,980 121
French drain	TPH Lead Chromium	133,000 738 962
Suspect spill site	Lead	6,930
Solvent UST	None	NA

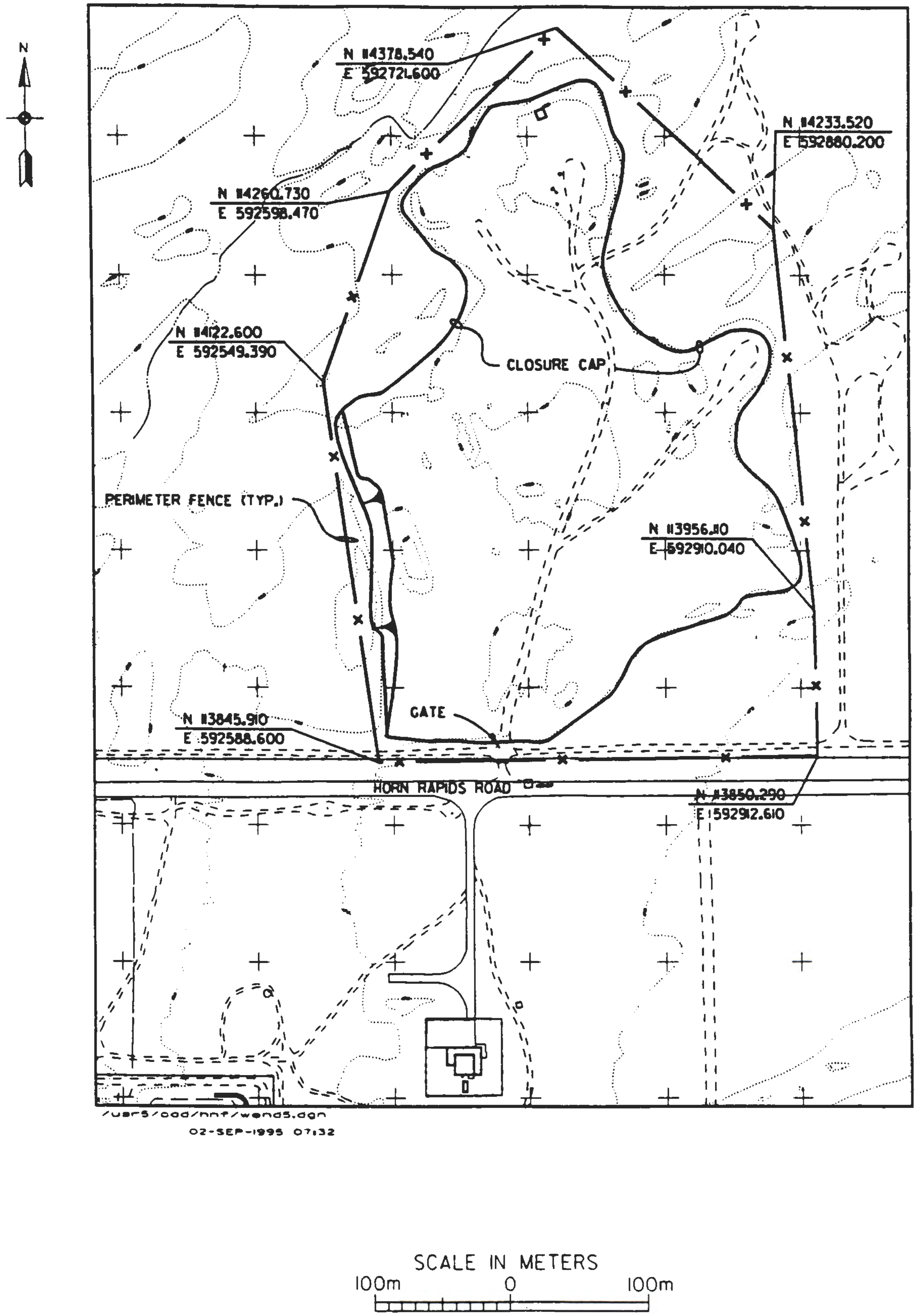
All hazardous waste that was sent off site for disposal was shipped in compliance with all federal, state, and local regulations, including air emission requirements (for the waste-loading operation), and was handled by a licensed hazardous waste transporter. The hazardous waste shipment manifests for each waste shipment have been retained in the project file, and certificates of disposal were obtained for the disposal of PCB-contaminated waste. The certificates of disposal have also been retained in the project file.

2.4.2 EM-1 Operable Unit

Remedial actions for the EM-1 began on January 3, 1995, with the clearing and road pioneering work at the HRL (the fence location and coordinates are shown in Figure 5). This work was followed by grading the slopes and preparing the foundation for the fill of closure cap, dismantling the burn cage at the HRL, and transporting the cage debris to the central portion of the landfill to be covered with the cap. The open trench within the HRL that contained tires was remediated by performing radiological surveys of the tires and having approximately 200 tires recycled by the Tire By-products Company of Spokane, Washington (tire transportation occurred between January 27 and February 7, 1995). Excavation of the PCB-contaminated soil at the HRL began on January 30, 1995, and continued until field sampling determined that residual concentrations were less than the established cleanup level (5 mg\kg).

The PCB-contaminated soil was excavated until field observance and field screening indicated that the soil did not exceed the 5 mg/kg cleanup criterion established in the ROD. The results of the confirmation sampling indicated that there was some contamination remaining that exceeded the cleanup criteria for PCBs, and additional removal was performed. The additional removal was accomplished in March 1995. A total of 1,224 m^3 (1,600 yd^3) of PCB-contaminated soil (principally, the PCB Aroclor-1248) was excavated and stockpiled for eventual disposal. The construction of the closure cap for the HRL began on January 10, 1995, and was constructed of material from a nearby borrow area (Pit #6). The construction methods and controls for cap

Figure 5. Perimeter Fence and Closure Cap Horn Rapids Landfill.



construction were performed, as required in DOE-RL 1995a. The random material layer, which comprises the lower portion of the cap, is 45 cm (18 in.) thick, and a 15-cm (6-in.) layer of topsoil material was placed over the surface. The location and extent of the cap is shown in Figure 5. The cap was completed on April 13, 1995. Reseeding of the cap to native vegetation will occur in the fall of 1995. Five groundwater-monitoring wells were installed in August 1995, downgradient of the landfill (Figure 6) to facilitate compliance evaluation and the remedial action objectives. Compliance with MCLs is anticipated by the year 2018. The design and installation of the wells were in accordance with *Washington Administrative Code* (WAC) requirements, as described in the work plan (DOE-RL 1995c), and to be consistent with other monitoring wells installed at the Hanford Site (well logs are shown in DOE-RL 1995e). Most of the remediation work at the HRL was accomplished by the Morrison Knudsen Environmental Corporation and their subcontractor, Morrison Excavation Company, except for the excavation and stockpiling of the PCB-contaminated soil by the CDM Federal Programs Corporation. The PCB-contaminated soil was disposed of at the Chemical Waste Management Facility in Arlington, Oregon, which is a RCRA, Class C/*Toxic Substances Control Act* (TSCA) hazardous waste landfill. The PCB-contaminated soil was transported between March 4 and April 12, 1995.

Revegetation of the site began on November 8, 1995, and was completed on November 14, 1995. The 25-acre HRL cap was seeded with a mixture of crested wheatgrass (*Agropyron cristatum*) and Siberian wheatgrass (*Agropyron sibericum*). Seeding was done by using a range drill and an Imprinter. Five different planting techniques were applied to determine the best technique for the conditions present and provide information that will be useful in planning future restoration projects.

The site was divided into five, roughly equal zones. Two zones were planted with the range drill. The first zone was fertilized with an application rate of 9.1 kg/acre (20 lb/acre) of nitrogen, seeded, and mulched with straw. The second zone, using the range drill, was seeded and mulched with straw with no fertilizer application. The comparison of these two zones will test the effects of limiting the amount of available nitrogen; a concept believed by many restoration experts to reduce the competitiveness of early successional weedy species, such as cheatgrass and Russian thistle.

The three other zones were used to test the efficacy of the Imprinter under the same soil conditions. The first included the application of seed, mycorrhizal fungi, and mulch. The second included the application of seed and mycorrhizal fungi with no mulch, and the third included the application of seed only with no mycorrhizal fungi or mulch.

Mycorrhizal fungi fill an important niche in native desert ecosystems. They form a symbiotic relationship with the roots of certain plants that is beneficial to the plant. The fungus is able to absorb nutrients from nutrient-poor soil and pass them on to the plant in exchange for sugars. Bunch grasses, such as the ones planted on the HRL, are known to form this relationship; weedy annual species such as cheatgrass and Russian thistle do not. Therefore, the application of the mycorrhizal fungi is intended to give the advantage to the desirable bunchgrasses.

The application of straw mulch is intended to reduce wind erosion and preserve soil moisture; it may also serve an added function to tie up excess available nitrogen that is believed to promote weed growth.

DISCOLORED SOIL SITE

Remediation of the discolored soil site began on February 14, 1995, with the excavation and stockpiling of 70 m^3 (90 yd^3) of waste material (principally, BEHP) in a manner as previously described in Section 1.5.1. Confirmation sampling indicated that the removal action met the cleanup levels established in the ROD. The site was regraded to a smooth, uniform surface. The contaminated soil was evacuated and stockpiled by CDM Federal Program Corporation and the waste was transported by Morrison Knudsen Environmental Corporation between April 19 and 25, 1995. The BEHP-contaminated soil was disposed of by incineration at Aptus, Incorporated, in Aragonite, Utah.

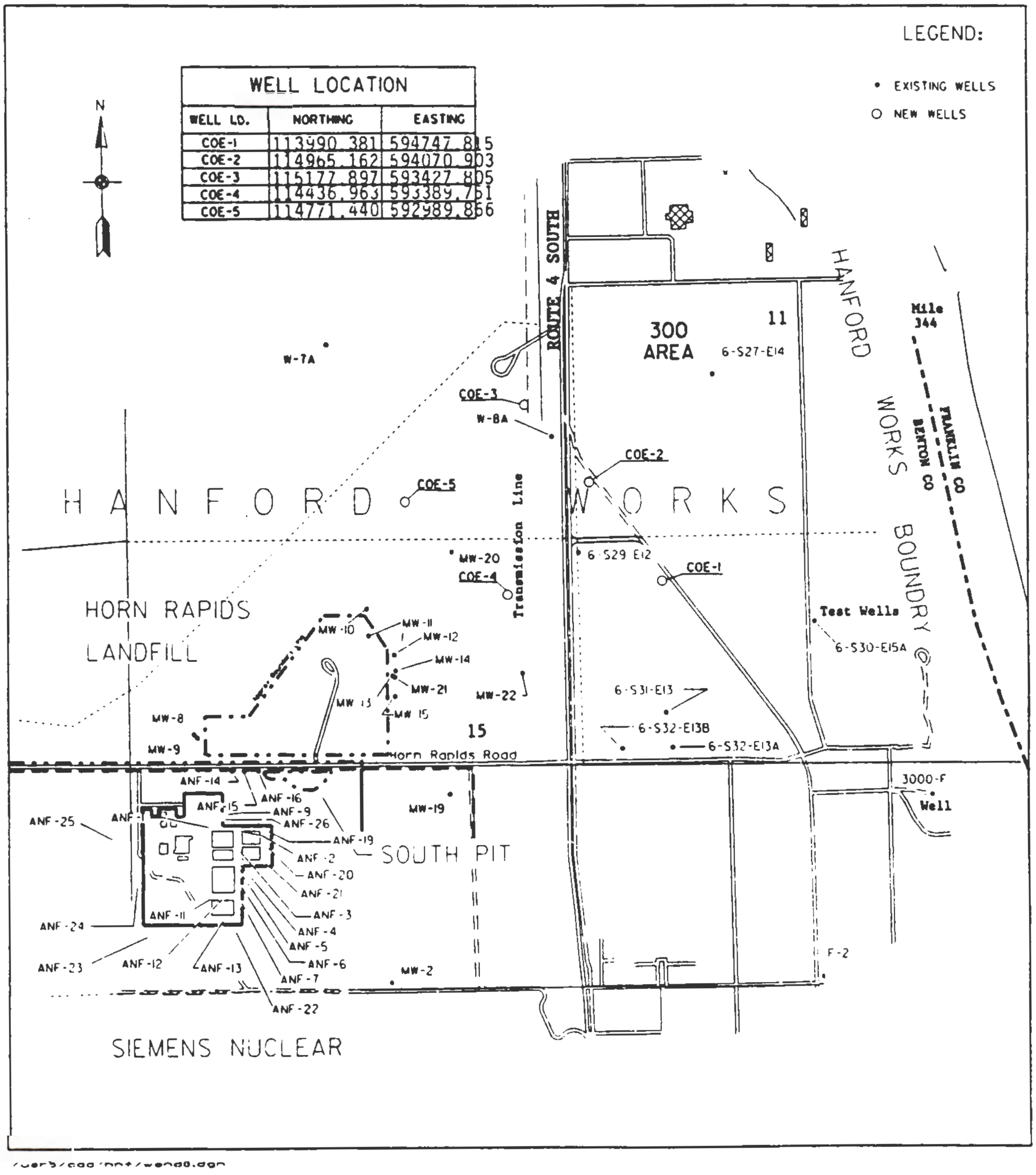
EPHEMERAL POOL

Ephemeral pool remediation began on February 9, 1995, with an initial phase of sampling. On March 11, 1995, excavation and stockpiling of waste (principally, the PCB Aroclor-1260) followed the procedure previously described in Section 2.4.1. Approximately 70 m^3 (90 yd^3) of contaminated soil was excavated, with a large volume of remaining contaminated soil having PCB-contamination concentrations of between 0.5 and 2 mg/kg when work was halted for consultation with the regulatory agencies and DOE. Following consultation, the final phase of the excavation and stockpiling resumed, and 115 m^3 (150 yd^3) of waste material was removed. Confirmation sampling indicated that the removal action met the requirements based on the cleanup levels established in the ROD. The site was regraded to a smooth, uniform surface. The contaminated soil was evacuated and stockpiled by CDM Federal Programs Corporation and was transported by Morrison Knudsen Environmental Corporation. The PCB-contaminated soil was disposed of at the Chemical Waste Management Facility in Arlington, Oregon, for disposal in a RCRA, Class C/TSCA hazardous waste landfill. The PCB-contaminated soil was transported on April 9, 1995.

2.4.3 EM-2 Operable Unit

Remediation of the tar flow area began June 26, 1995, with the excavation and stockpiling of 1,224 m^3 (1,600 yd^3) of petroleum-contaminated soil (PCS) in the manner previously described in Section 2.4.1. The volume of waste excavated and the effort associated with the cleanup was more significant than initially estimated during the investigation. Following excavation, confirmation sampling indicated that the removal actions met the requirements based on cleanup levels established in the ROD. The site was regraded to a smooth, uniform surface. The excavation and transportation of the contaminated soil was performed by CDM Federal Programs Corporation. The PCS-contaminated soil was disposed of at the Columbia Ridge Disposal Facility, which is a permitted PCS waste disposal facility. The waste was transported between September 13 and 19, 1995.

Figure 6. New Monitoring Well Locations.



WELL LOCATION		
WELL I.D.	NORTHING	EASTING
COE-1	113990.381	594747.815
COE-2	114965.162	594070.903
COE-3	115177.897	593427.805
COE-4	114436.963	593389.761
COE-5	114771.440	592989.866

2.4.4 EM-3 Operable Unit

The EM-3 remediation began with the solvent UST on June 22, 1995. Upon excavation of the solvent UST, it was observed that the site consisted of two tanks with vertical orientation and conical bases. One tank was filled with fluid, and the other tank had only a residual of fluid. The fluids were sampled, indicating that the contents were nonhazardous water. The fluids were removed and discharged to the Richland sanity sewer. The tanks were cleaned and removed to Twin City Metals, Inc., Kennewick, Washington, on July 11, 1995. Confirmation sampling was conducted, with samples collected from the soil below the tanks and the sides of the excavation, and no hazardous contaminants were detected.

Remediation of the suspect spill site began on July 7, 1995, with the excavation and stockpiling of 54 m^3 (70 yd^3) of lead-contaminated soil. The excavation proceeded in a manner as described in Section 2.4.1. Confirmation sampling indicated that the removal action met the requirements based on the cleanup levels established in the ROD. The site was regraded to a smooth condition, and 15 cm (6 in.) of base materials were spread over the disturbed area. The excavation and transportation of the contaminated soil was performed by CDM Federal Programs Corporation. The contaminated soil was stabilized (to meet the disposal requirements for lead) and disposed of at the Chemical Waste Management Facility in Arlington, Oregon, for disposal in a RCRA, Class C/TSCA hazardous waste landfill. The contaminated soil was transported between September 14 and 20, 1995.

French drain remediation began on July 11, 1995, with the excavation and stockpiling of 62 m^3 (80 yd^3) of soil contaminated with TPH, lead, and chromium. The excavation proceeded in a manner as described in Section 2.4.1. Confirmation sampling indicated that the removal action met the requirements based on the cleanup levels established in the ROD. The site was regraded to a smooth condition, and 15 cm (6 in.) of base materials were spread over the disturbed area. The excavation and transportation of the contaminated soil was performed by CDM Federal Programs Corporation. The contaminated soil was disposed of at the Chemical Waste Management Facility in Arlington, Oregon, for disposal in a RCRA, Class C/TSCA hazardous waste landfill. The contaminated soil was transported between September 14 and 20, 1995.

3.0 DEMONSTRATION OF QUALITY ASSURANCE/QUALITY CONTROL FROM CLEANUP ACTIVITIES

The QA and QC procedures and protocol for the remedial actions were defined in work plans and were reviewed and approved by EPA, Ecology, and DOE before beginning field work (DOE-RL 1995a, DOE-RL 1995b, and DOE-RL 1995d). Documentation of those procedures is shown in DOE-RL 1995e. Samples were collected, shipped, and analyzed under strict chain-of-custody requirements and according to the most current EPA SW-846 and Contract Laboratory Program (CLP) analytical methods. Sampling conducted, in addition to that anticipated in the field sampling plans, was guided by *Statistical Guidance for Ecology Site Managers* (Ecology 1992) and preapproved by the appropriate regulators.

In addition to the internal laboratory data quality review for levels three and four, the deliverables and method-specific requirements for data QC, other procedures were employed to ensure data quality. All chemical laboratories that were used were validated under a proficiency program administered by the USACE NPD. Specific radioisotope analyses were conducted by laboratories monitored by the Environmental Measurement Laboratories proficiency program, per DOE Order 5400.1, with independent verification analyses from both Oak Ridge and the Washington State Department of Health. At least 10% of all samples were split for blind duplicate analyses, and another 10% of the samples were split for independent-check laboratory analyses. The data from these splits, as well as all of the associated QC data, were reviewed by the QA section of North Pacific Division Laboratory of the USACE NPD. Project-specific chemical QA reports of this data validation were issued to the project manager. In addition to this, the data from each of the original 11 rounds of groundwater sampling and 10% of the subsequent rounds were independently validated using the *Data Validation Procedures for Chemical Analyses* (WHC 1992), and *Data Validation Procedures for Radiological Analyses*, (WHC 1991).

These practices, combined with contractor oversight by technically competent field personnel and continuous data review by the technical manager, has produced continuing data of sufficient quality to meet the objectives of monitoring, characterization, and remedial confirmation.

4.0 SCREENING SAMPLING AND CONFIRMATION SAMPLE RESULTS

Remedial action sampling included screening and confirming samples (documentation of those results is reported in DOE-RL 1995e). After excavation of suspected contaminated materials had begun, screening samples were collected from the soil (at the base and walls) at regular intervals to determine the presence or absence of contaminants that exceed acceptable cleanup levels established in the ROD. These samples were analyzed in an onsite laboratory or with field test kits, providing rapid turnaround using at least EPA QC Level II analytical reporting methods. Analytical results for screening samples were typically available within 3 hours of sampling and collection. Maximum contaminant concentrations indicated by the screening samples for each site are summarized in Table 5.

When all contaminated soil had been removed from a site (as demonstrated by the screening samples' analytical results collected from the excavated area), confirmation samples were collected for offsite laboratory analysis. Analyses were performed on a quick turnaround basis, with initial results available within 48 hours of receipt by the laboratory. These analyses were conducted in accordance with EPA QC Level III data requirements, with 10% meeting EPA QC Level IV equivalent data requirements. At least 10% of all confirmation samples were split and submitted to the USACE NPD for analysis as independent QA samples.

Remedial action attainment criteria were developed jointly by EPA and Ecology. Guidance for numerical standards application was established in MTCA guidance, was formalized in WAC 173-340-740(7)9d, and was used as the basis of these criteria. Contaminated sites were considered fully remediated if the following were true:

- The upper-confidence interval on a true soil concentration is less than the soil cleanup level. Statistical tests would be performed at Type I, error level of 0.05 (95% upper-confidence level).
- No single sample concentration is greater than two times the soil cleanup level.
- Less than 15% of the sample concentrations exceed the soil cleanup level.

If the sample sets were tested for normality or log-normality and failed, it was agreed that the approximate calculation method for the one-sided upper-confidence limit (presented in Section 5.2.1.3 of the Ecology's *Statistical Guidance for Ecology Site Manager* [Ecology 1992]) would be used.

5.0 FUTURE ACTIONS/FIVE-YEAR REVIEW

The cleanup actions for EM-2 and EM-3 are complete, but the completion of the EM-1 is dependent upon achieving compliance with the remedial action objectives for groundwater at the HRL. Continued groundwater monitoring is necessary to verify the modeled contaminant attenuation predictions and to evaluate the need for active remedial measures. The monitoring plan has previously been determined (DOE-RL 1995c) and establishes a sampling schedule and monitoring procedures that will monitor the achievement of remedial action objectives. The wells that comprise the monitoring network are identified in Table 6. The objective of sampling during the first 5-year period will be to continue to monitor wells downgradient of the HRL for TCE; vinyl chloride; 1,1-dichloroethene and nitrate; and although not specified in the ROD, to contine monitoring MW-3 (a well downgradient of the 1171 Building) for chromium because of the high variability of data that has been reported in sampling of the well. A summary of the constituent, container, and analysis requirements specified in the monitoring plan (DOE-RL 1995) is provided in Table 7. All sampling will be performed by the ERC in compliance with BHI-EE-01 procedures.

If the monitoring does not confirm the predicted decrease of contaminant levels (as estimated in the RI/FS), then EPA, Ecology, and DOE will evaluate the need to perform additional response actions. The EPA will review the groundwater monitoring data for the HRL in 5 years to evaluate attenuation progress.

Future actions at the HRL must include continuing institutional control, which includes maintaining security, the integrity of the fence around the HRL, and the integrity of the closure cap. Monitoring the success of the revegetation efforts will be conducted annually in the spring, to measure the effectiveness of the various applications. The ultimate measure of success or failure can only be measured after several growing seasons (perhaps 3 to 5). Monitoring will consist of a variety of measurements, including survival rate, stem count, percent canopy cover, and reproductive success. These parameters will be measured and compared among the different treatments. These measurements will also show the effectiveness of the different planting techniques on controlling weed growth. It is anticipated that all applications will be

Table 6. Well Identification Table.

Well Name	Well ID	Location
MW-10	699-S30-E10A	Downgradient of Horn Rapids Landfill
MW-11	699-S30-E10B	Downgradient of Horn Rapids Landfill
MW-12	699-S31-E10A	Downgradient of Horn Rapids Landfill
MW-14	699-S31-E10C	Downgradient of Horn Rapids Landfill
MW-15	699-S31-E10D	Downgradient of Horn Rapids Landfill
MW-20	699-S29-E11	Downgradient of Horn Rapids Landfill
MW-22	699-S31-E11	Downgradient of Horn Rapids Landfill
--	699-S29-E12	Downgradient of Horn Rapids Landfill
MW-3	699-S41-E12	Downgradient of 1171 Building
COE-1	699-S29-E13A	SE End Point of Compliance
COE-2	699-S28-E13A	Center Point of Compliance
COE-3	699-S27-E12A	N.W. End Point of Compliance
COE-4	699-S30-E11A	Upgradient of Point of Compliance
COE-5	699-S29-E10A	Upgradient of Point of Compliance

Table 7. Sampling Parameters.

Measurement Parameter (Detection Limit)	Container/Preservation	Reference
TCE (0.1 µg/l) Vinyl Chloride (0.1 µg/l) 1,1-dichloroethene (0.1 µg/l)	3 x 40 ml glass vials with Teflon™ -lined septa; pH <2 with HCL; Cooled to 4°C.	EPA SW 846 Method 8260
Nitrate (20 µg/l)	1 liter Poly; Cooled to 4°C; Analyzed within 48 hours of sampling.	EPA SW 846 Method 300 series
Chromium[a] (7 µg/l)	1 liter Poly with Teflon™-lined cap; pH <2 with metal-free HNO_3; Cooled to 4°C.	EPA SW 846 Method 6010 (ICP) Digestion via 3010

[a]For MW-3 only.

successful in producing a viable population of wheatgrass that will stabilize the site. The comparison of the different planting techniques should provide valuable information on the best method to obtain a desired grass cover with the least amount of weeds in the shortest time.

Continued monitoring is also required for monitoring wells 1 and 3 so a better definition exists of any trend in concentration increase or decrease. Continued monitoring helps track the migration of contaminants into the 1100 Area from offsite sources. The results of the monitoring will be reviewed at the 5-year review, and DOE, EPA, and Ecology will determine if further action is warranted.

6.0 PROTECTIVENESS

Remediation of the EM-1, EM-2, and EM-3 Operable Units has been accomplished, and all soil contamination has been removed to comply with cleanup levels specified in the ROD. The soil removal and the cap installation at the HRL in the EM-1 have reduced the incremental cancer risk from 4×10^{-3} (before remediation) to 3×10^{-5} (after remediation), based on the residential baseline risk analysis. The groundwater monitoring and institutional controls will prevent exposure to contaminated groundwater at the HRL until compliance level attenuation is achieved. A quantitative risk assessment analysis was not performed for EM-2 and EM-3, but the cleanup requirements for contaminated sites in these operable units were based on remedial action objectives for residential use. Consequently, the cleanup of these sites will be protective of human health (estimated to be less than 10^{-5} in the ROD) and will provide protection of groundwater resources located below the sites.

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